AD624789

STATUS REPORT

Contract Number: NONR 595 (10)

Chief Investigator: Dr. Hans R. Griem

Period Covered: September 1, 1965 - November 30, 1965



Submitted by the
Department of Physics and Astronomy
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College Park, Maryland

## EXPERIMENTAL PROGRAM

### (a) Measurement of Stark Broadening of Lines from Light Elements.

The paper on "Measurement of Stark Profiles of Singly Ionized Nitrogen Lines from a T-Tube Plasma" has been published[1] in November. In continuation of this work measurements are in progress on the intercomparison of HeI and hydrogen lines emitted from the same plasma. This will serve to verify empirical corrections to HeI line widths used in the ionized nitrogen measurements. It has already become apparent that there exist certain discrepancies between theoretical and experimental HeI line profiles at high electron densities. In particular, it was found that the experimental profile of the line HeI 6678Å was approximately a factor of 2 narrower than the one calculated for the measured electron density of $10^{18} cm^{-3}$. This discrepancy is not too surprising, since the profiles of isolated HeI lines were calculated without taking into account Debye screening of the perturbing electrons. This is only justified as long as the plasma frequency is small compared to the separation between the upper level of the line and the nearest perturbing level, a condition that is violated in this particular case. In order to get detailed high-density correction factors to the theoretical line profiles, an intercomparison between hydrogen and helium line profiles is being

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[1] R. A. Day and H. R. Griem, Phys. Rev. 140, A1129 (1965).

made over electron densities between $10^{16}$ and $10^{18} cm^{-3}$. So far, this has been completed for the line HeI 5876Å, and further lines are under investigation.

(b) Measurements of UV Radiation from Shock-Heated Plasmas.

The paper on "Method for the Determination of Atomic Resonance Line Oscillator Strengths from Widths of Optically Thick Emission Lines in T Tube Plasmas" has been accepted for publication in The Physical Review. Another experiment is now being set up to study the effects of vacuum UV precursor radiation in electromagnetic T-tubes. It is intended to perform end-on observations with narrowband UV detectors as developed in our laboratory.[2]

(c) Collisionless Plasma Shockwave Experiment.

We have made space and time resolved observations of line emission from a small amount of carbon impurity in the system. Observations were made prior to and during the passage of the wave structure described previously.[3] The initial plasma has the following parameters: $n_e \cong 2 \times 10^{14} cm^{-3}$, $kT_e = 1.4 eV$ and $B_o = -650G$.

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[2] R. Lincke and G. Palumbo, Appl. Opt. (in press).

[3] G. C. Goldenbaum and E. A. Hintz, Phys. Fluids (November, 1965).

The wave front has a magnetic structure with a [illegible] of about one centimeter. This agrees with estimates of Sagdeev[4] based on electrostatic turbulence and Fishman, Kantrowitz and Petschek[5] who assume hydromagnetic turbulence develops.

The carbon ion line emission was measured along a line of sight parallel to the axis but displaced off the axis by two centimeters. The area viewed was of the order of two by seven millimeters. Lines from carbon II, III and IV were observed. The lines start to appear just at the time the magnetic disturbance arrives at the two centimeter position. The relative times of appearance of the different stages of ionization and the absence of CV lines together with estimates of the relevant electron impact ionization cross sections give an electron temperature greater than 50eV and less than 150eV in the shock front. These temperatures are much greater than predicted either for Joule heating using the Spitzer-Härm conductivity or for heating by adiabatic compression alone. The results are consistent with the estimates of Sagdeev.

A research note has been accepted for publication in the November issue of Physics of Fluids.[3] In addition a paper was given in San Francisco at the 1965 meeting of the Plasma Physics Division of the American Physical Society. An abstract of this paper and a copy of the research note are appended to this report.

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[4] R. Sagdeev, American Mathematical Society Symposium in Mathematics (in press).

[5] F. J. Fishman, A. R. Kantrowitz and H. E. Petschek, Rev. Modern Phys. 32, 959 (1960).

(d) Plasma Diagnostics by Light Scattering.

The light scattering equipment has been set up on the collision-free shock experiment and preliminary results were obtained. The laser light scattered from a small volume of plasma in the region traversed by a Mach 3 shock wave under approximately collisionless conditions is analyzed to provide information on electron density and energy. Spatial and time resolutions of order 1mm and 20nsec are obtained. The shock runs radially inward into an initially uniform plasma with $B_z = -650G$, density $\sim 2 \times 10^{14} cm^{-3}$ and temperature $\sim$ 1eV in a $\Theta$-pinch geometry. Scattering measurements at two wavelengths in the preheated plasma support the previous spectroscopic determinations of temperature and density. The scattered light from a region 1.8cm off the tube axis shows the arrival of a compressional wave accompanied by electron heating. The shock front has thickness $\sim$ 1cm, consistent with probe measurements.[3] Within the shock the electrons are shown to be heated, but the measurements are not consistent with an isotropic Maxwellian velocity distribution. The arrival of a large density jump associated with the magnetic piston is clearly seen.

(e) Theoretical Program.

The papers on "Theory of Resonance Broadening of Spectral Lines by Atom-Atom Impacts" and on "Theory of Wing Broadening of the Hydrogen Lyman-α Line by Electrons and Ions in a Plasma"

have been published in November.[6,7] We now consider [illegible]ions of complete Stark profiles for high members of the Balmer series and a study of combined resonance and Doppler broadening.

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[6] A. W. Ali and H. R. Griem, Phys. Rev. **140**, A1044 (1965).

[7] H. R. Griem, Phys. Rev. **140**, A1140 (1965).

FISCAL INFORMATION

As of November 5, 1965:

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| The unexpended balance on the contract is | $43,468.24 |
| The unobligated amount on the contract is | $31,118.27 |